

1. RALPH EDWARD MILLIKEN

Department of Earth, Environmental & Planetary Sciences
Brown University
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2. EDUCATION

- Ph. D. Brown University Department of Geological Sciences 2006
Quantifying and modeling the water content of geological materials using VIS-NIR reflectance spectroscopy: Applications for laboratory and spacecraft data
- Sc. M. Brown University Department of Geological Sciences 2003
Viscous flow features on the surface of Mars: Observations from high-resolution Mars Orbiter Camera (MOC) images
- B. S. Indiana University Department of Geological Sciences 2001
minors awarded in physics and mathematics
Microbial sulfate-reduction in waters from ultra-deep South African gold mines

3. PROFESSIONAL APPOINTMENTS/EXPERIENCE

- 2025 – present Professor Brown University
2022 – present Director, NASA [Rhode Island Space Grant Consortium](#)
2022 – present Director, NASA [Rhode Island EPSCoR program](#)
2012 – present Director, NASA [Reflectance Experiment LAboratory \(RELAB\)](#)
- 2017 – 2025 Associate Professor Brown University
- 2012 – 2017 Assistant Professor Brown University
- 2010 – 2012 Assistant Professor University of Notre Dame
- 2007 – 2010 Research Scientist Jet Propulsion Laboratory/Caltech
- 2006 – 2007 Post-Doctoral Scholar Caltech/Jet Propulsion Laboratory
advisor: Dr. John Grotzinger
- 2001 – 2006 Graduate Student Research Assistant Brown University
advisor: Dr. John Mustard
- 1999 – 2001 Undergraduate Research/Lab Assistant Indiana University
advisor: Dr. Lisa Pratt
- 1999 – 2000 Undergraduate Research Indiana University
1998 – 2000 GSA Editorial Assistant Indiana University
advisor: Dr. Abhijit Basu

4. NASA & INTERNATIONAL MISSION EXPERIENCE

- Participating Scientist on NASA Mars Science Laboratory (*Curiosity*) rover [NASA]
- Co-Investigator for OSIRIS-REx mission Sample Analysis Team [NASA]
- Co-Investigator for Hayabusa2 NIRS3 instrument & sample analysis team [JAXA]
- Co-Investigator on Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) instrument on Mars Reconnaissance Orbiter [NASA]
- Collaborator with Mars Express OMEGA spectrometer team [ESA; IAS]

5. PUBLICATIONS

[H-Index: 77 Citations >27,700 from Google Scholar 7/2026]

a. Books

Sedimentary Geology of Mars (2012) eds. J. P. Grotzinger and R. E. Milliken, *SEPM Special Paper*, SP102, 276 pp.

b. Refereed Journal Articles & Book Chapters

In Prep (completed M.S./Ph.D. thesis chapters) (4) (*student advisee)

*Meyer, M., K. Robertson, and R.E. Milliken (2026), Integration of hyperspectral image analysis for improved geologic mapping in sedimentary successions: A case study in the Guadalupe Mountains of New Mexico and Texas, Part 1: Geologic Mapping Methods, *AAPG Bulletin*, draft available upon request.

*Meyer, M., R.E. Milliken, and K. Robertson (2026), Integration of hyperspectral image analysis for improved geologic mapping in sedimentary successions: A case study in the Guadalupe Mountains of New Mexico and Texas, Part 2: Insights from hyperspectral geologic mapping, *AAPG Bulletin*, draft available upon request.

*Fisher, E. A., R.E. Milliken, K. Robertson and S. Li (2026), Determining the modal mineralogy of howardites and brecciated eucrites: A combined X-ray diffraction and visible-near infrared reflectance study, *Meteoritics & Planetary Science*, draft available upon request.

Dworkin, J. et al. (2026), OSIRIS-REx returned a pristine sample of asteroid Bennu, *Space Science Reviews*, in prep.

Submitted/In Review (7) (* indicates student advisee; † indicates postdoctoral advisee)

*Yanez, K., R.E. Milliken, K. Robertson, M. Coronado, J. Hurowitz (2026), Limits of lithologic discrimination in basaltic systems: Insights from spatially resolved and bulk measurements applied to Mars, *The Planetary Science Journal*, in review.

*Schultz, C. D., R. E. Milliken, T. Hiroi, S. A. Sandford, V. E. Hamilton, E. A. Cloutis, N. Bowles, H. C. Connolly, Jr., and D. S. Lauretta (2026), Evidence of fluid evolution and surface weathering in near- to mid-infrared spectra of samples from asteroid Bennu, *Science Advances*, in review.

*Rojas, A., E. H. G. Cooperdock, R. E. Milliken, E. Hodgins, K. Robertson, T. Parsons, and P. Nguyen (2026), Fe-rich surface mineralization limits ultramafic weathering in natural systems, *JGR Earth Surfaces*, in review.

*Czernik, T., K. Robertson, C. Myers, R.E. Milliken, G. Hirth, R. Cooper (2026), Limits of spectral detectability of solids in the ice Ih-MgCl₂·12H₂O system: Implications for Europa, *Icarus*, in review.

Yumoto, K. et al. (2026), Skin-deep difference between asteroids Ryugu and Bennu driven by the grain-size evolution of surface materials, *Nature Astronomy*, in review.

Huang, Y., E. Santos, M. R. Alexandre, R. E. Milliken, P. R. Heck, Y. Zheng, D. P. Glavin, J. P. Dworkin, C. M. O'D. Alexander, H. C. Connolly Jr., and D. S. Lauretta (2026), Molecular and isotopic evidence for interstellar and parent body-derived volatile hydrocarbons in samples of asteroids Bennu and Ryugu, *Nature Astronomy*, in review.

Huang, Y. et al. (2026), Protocell-essential membrane lipids in samples of carbonaceous asteroids and meteorites, *Nature Communications*, *in review*.

Published/In-Press (* indicates student advisee; † indicates postdoctoral advisee)

2026

139. Cloutis, E.A., D.M. Applin, A.A. Simon, B.E. Clark, X.-D. Zou, V.E. Hamilton, R.E. Milliken, T. Hiroi, M.E. Zolensky, K.M. Peters, L.P. Keller, D.N. DellaGiustina, H.C. Connolly Jr., D.S. Lauretta (2026), Reflectance spectroscopy (250-2500 nm) of an aggregate sample from asteroid (101955) Bennu, *Icarus*, 460, doi: 10.1016/j.icarus.2026.117289, **in press**.
138. *Anzures, B., *C. Schultz, R.E. Milliken, T. Hiroi, J. Clark, P. Casbeer, and I. Külaots (2026), Assessing effects of particle size on water content estimates of carbonaceous chondrites and their parent bodies, *Geological Society of London Special Publication*, **in press**.
137. Milliken, R.E., T. Hiroi, V.E. Hamilton, C. D. Schultz, E. Cloutis, H. Kaplan, M. Kontogiannis, N. Vega-Santiago, D. DellaGiustina, H. C. Connolly, Jr., D. S. Lauretta (2026), The role of composition in the spectral evolution of carbonaceous asteroids as informed by Bennu sample return, *Meteoritics & Planetary Science*, **in press**.
136. Hamilton, V. E., E. A. Cloutis, R. E. Milliken, P. Haenecour, D. R Golish, K. J. Domanik, T. J. McCoy, L. P. Keller, A.A. Simon, H. H. Kaplan, C. A. Goodrich, S. A. Sandford, D. Applin, T. Hiroi, D. Hill, N. G. Lunning, F. M. McCubbin, S. A. Eckley C. J. Snead, E. H. Blumenfeld, J. E. Aebersold, C. Schultz, N. Bowles, K. Shirley, S. S. Russell, J. J. Barnes, T. J. Zega, D. N. DellaGiustina, A. Ryan, D. P. Glavin, J. P. Dworkin, H. C. Connolly, Jr., and D. S. Lauretta (2026), Visible, near- and thermal infrared spectra of asteroid Bennu samples: Relationship to and implications for remote sensing of carbonaceous asteroids, *Meteoritics & Planetary Science*, **in press**, doi: 10.1111/maps.70176.
135. Gasda, P.J. et al. (2026), Ampari marker band metal-enrichments: Potential mechanisms and implications for surface and subsurface water and weathering in Gale crater, *JGR Planets*, 2025JE009153, doi: 10.1029/2025JE009153.
134. Jung, Ji-In, M. Lapotre, R.E. Milliken, and S. Minson (2026), Remote compositional analyses of space-weathered lunar maria, *The Planetary Science Journal*, 7(18), doi:10.3847/PSJ/ae2b57.

2025

133. Kite, E., B. Tutolo, M. Turner, H. Franz, D. Burt, T. Bristow, W. Fischer, R.E. Milliken, A. Fraeman, D. Zhou (2025), Carbonate formation and fluctuating habitability on Mars, *Nature*, 643, 60-66, doi: 10.1038/s41586-025-09161-1.
132. Das, E., T.D. Glotch, C.S. Edwards, C. Ye, R.E. Milliken, A.D. Rogers, & L. Ehm (2025), Remote Determination of Martian Chloride Salt Abundances, *JGR Planets*, 130, e2024JE00854, doi: 10.1029/2024JE008541.
131. *Schultz, C., R.E. Milliken, J. Boesenberg, and I. Kerraouch (2025), Spectral diversity in the Aguas Zarcas carbonaceous chondrite and implications for inferring aqueous processes on

primitive asteroids using remote sensing, *Meteoritics & Planetary Science*, 1-40, doi: 10.1111/maps.14339.

130. Milliken, R.E. & J. Cuadros (2025), Chapter 12: Interstratified Clay Minerals on Mars, in *Clay on Mars*, ed. J. Cuadros, Developments in Clay Science, v. 12, Elsevier Press, 329-358, doi: 10.1016/B978-0-443-21614-5.00010-9
129. Tosca, N. and R.E. Milliken (2025), Chapter 9: Clays of Apparent Hydrothermal Origin, in *Clay on Mars*, ed. J. Cuadros, Developments in Clay Science, v. 12, Elsevier Press, 237-270, doi: 10.1016/B978-0-443-21614-5.00001-8
128. Huang, Y., E. Santos, M.R. Alexandre, P.R. Heck, R.E. Milliken, D.P. Glavin, and J.P. Dworkin (2025), Highly efficient compositional and compound specific isotopic analysis of volatiles primary amines and ammonia in the Murchison meteorite using SPME on-fiber derivatization: Optimization for Bennu sample analysis, *Rapid Communications in Mass Spectrometry*, 39:e9979, doi: 10.1002/rcm9979.
127. *Schultz, C. and R.E. Milliken (2025), The curious case of the missing mantle: How carbonaceous chondrites may confound the spectral identification of partially differentiated asteroids, *Icarus*, 116442, doi: 10.1016/j.icarus.2024.116442.
126. *Anzures, B.A., S.W. Parman, R.E. Milliken, O. Namur, C. Cartier, F.M. McCubbin, K.E. Vander Kaaden, K. Prissel, K. Iacovino, A. Lanzirotti, and M. Newville (2025), An oxygen fugacity-temperature-pressure-composition model for sulfide speciation in mercurian magmas, *Geochimica et Cosmochimica Acta*, 388, 61-77, doi: 10.1016/j.gca.2024.11.012.

2024

125. Clark, J.V., B. Sutter, A.C. McAdam, J.M.T. Lewis, H. Franz, P.D. Archer, L. Chou, J. Eigenbrode, C. Knudson, J. Stern, D. Glavin, A. Steele, C. H. House, J. Schroeder, J. Berger, E.B. Rampe, S. Simpson, B. Tutolo, R.E. Milliken, C. Malespin, P. Mahaffy, and A. Vasavada (2024), Environmental changes recorded in sedimentary rocks in the clay-sulfate transition region in Gale crater, Mars: Results from the Sample Analysis at Mars-Evolved Gas Analysis Instrument onboard the Mars Science Laboratory *Curiosity* rover, *JGR Planets*, 129, e2024JE008587, doi:10.1029/2024JE008587.
124. Laurretta, D.S., H.C. Connolly Jr., J. Aebersold, C.M. O. D. Alexander, R. Ballouz, J. Barnes, H. Bates, C. Bennett, L. Blanche, E. Blumenfeld, S. Clemett, G. Cody, D. DellaGiustina, J. Dworkin, S. Eckley, D. Foustoukos, I. Franchi, D. Glavin, R. Greenwood, P. Haenecour, V. Hamilton, D. Hill, T. Hiroi, K. Ishimaru, F. Jourdan, H. Kaplan, L. Keller, A. King, P. Koefoed, M. Kontogiannis, L. Le, R. Macke, T. McCoy, R.E. Milliken, J. Najorka, A. Nguyen, M. Pajola, A. Polit, H. Roper, S. Russell, A. Ryan, S. Sandford, P. Schofield, C. Schultz, S. Tachibana, K. Thomas-Keppta, M. Thompson, V. Tu, F. Tusberty, K. Wang, T. Zega, C. Wolner, and the OSIRIS-REx Sample Analysis Team (2024), Asteroid (101955) Bennu in the laboratory: Properties of the sample collected by OSIRIS-REx, *Meteoritics & Planetary Science*, 59(9), 2453-2486, doi:10.1111/maps.14227.
123. *Meyer, M., R.E. Milliken, K. Stack, L. Edgar, E. Rampe, M. Turner, K. Lewis, E. Kite, G. Caravaca, A. Vasavada, W. Dietrich, A. Bryk, O. Gasnault, S. Le Mouélic, C. Seeger, and R. Sheppard (2024), The geological context and significance of the clay-sulfate transition region in Mt. Sharp, Gale Crater, Mars: An integrated assessment based on orbiter and rover data, *GSA Bulletin*, doi:10.1130/B37355.1.
122. *Wilk, K., J.F. Mustard, R.E. Milliken and C.M. Pieters (2024), Variations in surface adsorbed H₂O on lunar soils and relevant minerals, *Icarus*, 411, doi.org/10.1016/j.icarus.2024.115945.

121. *Yang, Y., R.E. Milliken, M.S. Bramble, W.R. Patterson, Y. Zou, and Y. Liu (2024), Laboratory thermal emission spectral measurement and calibration methods for planetary science research, *Chinese Journal of Space Science*, 44, 1-17.

2023

120. Amano, K., M. Matsuoka, T. Nakamura, E. Kagawa, Y. Fujioka, S. M. Potin, T. Hiroi, E. Tatsumi, R.E. Milliken, E., E. Quirico, P. Beck, R. Brunetto, M. Uesugi, Y. Takahashi, T. Kawai, S. Yamashita, Y. Enokido, T. Wada, Y. Furukawa, M. E. Zolensky, D. Takir, D. L. Domingue, C. Jaramillo-Correa, F. Vilas, A. R. Hendrix, M. Kikuri, T. Morita, H. Yurimoto, T. Noguchi, R. Okazaki, H. Yabuta, H. Naraoka, K. Sakamoto, S. Tachibana, T. Yada, M. Nishimura, A. Nakato, A. Miyazaki, K. Yogata, M. Abe, T. Okada, T. Usui, M. Yoshikawa, T. Saiki, S. Tanaka, F. Terui, S. Nakazawa, S.-i. Watanabe, and Y. Tsuda (2023), Re-assessing parent bodies of CI chondrites based on reflectance spectral analyses of the samples from the carbonaceous asteroid Ryugu, *Science Advances*, 9(49), doi:10.1126/sciadv.adi3789.
119. Matsuoka, M., E.-i. Kagawa, K. Amano, T. Nakamura, E. Tatsumi, T. Osawa, T. Hiroi, R.E. Milliken, D. Domingue, D. Takir, R. Brunetto, A. Barucci, K. Kitazato, S. Sugita, Y. Fujioka, O. Sasaki, S. Kobayashi, T. Iwata, T. Morota, Y. Yokota, T. Kouyama, R. Honda, S. Kameda, Y. Cho, K. Yoshioka, H. Sawada, M. Hayakawa, N. Sakatani, M. Yamada, H. Suzuki, C. Honda, K. Ogawa, K. Shirai, C. Lantz, S. Rubino, H. Yurimoto, T. Noguchi, R. Okazaki, H. Yabuta, H. Naraoka, K. Sakamoto, S. Tachibana, T. Yada, M. Nishimura, A. Nakato, A. Miyazaki, K. Yogata, M. Abe, T. Okada, T. Usui, M. Yoshikawa, T. Saiki, S. Tanaka, F. Terui, S. Nakazawa, S.-i. Watanabe, and Y. Tsuda (2023), Space weathering acts strongly on the uppermost surface of Ryugu, (*Nature*) *Communications Earth & Environment*, 4, 335, doi:10.1038/s43247-023-00991-3.
118. Hiroi, T., R.E. Milliken, K.M. Robertson, C.D. Schultz, K. Amano, T. Nakamura, H. Yurimoto, T. Noguchi, R. Okazaki, H. Naraoka, H. Yabuta, K. Sakamoto, T. Yada, M. Nishimura, A. Nakato, A. Miyazaki, K. Yogata, M. Abe, T. Okada, T. Usui, M. Yoshikawa, T. Saiki, S. Tanaka, S. Nakazawa, Y. Yokota, E. Tatsumi, Y. Tsuda, S. Tachibana, T. Fuyuto, S. Watanabe, S. Sasaki, H. Kaiden, K. Kitazato, and M. Matsuoka (2023), Evidence of global space weathering by solar wind on asteroid 162173 Ryugu, *Icarus*, 406, doi:10.1016/j.icarus.2023.115755.
117. Brunetto, R., C. Lantz, Y. Fukuda, A., Aléon-Toppani, T. Nakamura, Z. Dionnet, D. Baklouti, F. Borondics, Z. Djouadi, S. Rubino, K. Amano, M. Matsumoto, Y. Fujioka, T. Morita, M. Kikuri, E. Kagawa, M. Matsuoka, R.E. Milliken, H. Yurimoto, T. Noguchi, R. Okazaki, H. Yabuta, H. Naraoka, K. Sakamoto, S. Tachibana, T. Yada, M. Nishimura, A. Nakato, A. Miyazaki, K. Yogata, M. Abe, T. Okada, T. Usui, M. Yoshikawa, T. Saiki, S. Tanaka, F. Terui, S. Nakazawa, S. Watanabe, Y. Tsuda (2023), Ryugu's anhydrous ingredients and their spectral link to primitive dust from the outer Solar System, *Astrophysical Journal Letters*, 951:L33, doi: 10.3847/2041-8213/acdf5c.
116. *Meyer, M., R.E. Milliken, J.A. Hurowitz and K. Robertson (2023), Ancient siliciclastic-evaporites as seen by remote sensing instrumentation with implications for the rover-scale exploration of sedimentary environments on Mars, *Astrobiology*, 23(5), doi: 10.1089/ast.2022.0103.
115. *Schultz, C., *B. Anzures, R.E. Milliken, T. Hiroi and K. Robertson (2023), Diversity of hydration features in CM2 chondrites as seen in μ FTIR reflectance spectra and implications for primitive asteroids, *Meteoritics & Planetary Science*, doi:10.1111/maps.13946

114. Y. Zhuang, H. Zhang, P. Ma, T. Jiang, Y. Yang, R.E. Milliken, and W. Hsu (2023), Visible and near-infrared reflectance spectra of igneous rocks and their powders, *Icarus*, 391, doi:10.1016/j.icarus.2022.115346.

2022

113. Nakamura, T.+220 co-authors (non-alphabetical, R.E. Milliken is 26th) (2022), Formation and evolution of carbonaceous asteroid Ryugu: Direct evidence from returned samples, *Science*, 379(6634), doi: 10.1126/science.abn8671.
112. *Sheppard, R.Y., R.E. Milliken, and K.M. Robertson (2022), Presence of clay minerals can obscure spectral evidence of Mg sulfates: Implications for orbital observations of Mars, *Icarus*, 383, 115083, doi: 10.1016/j.icarus.2022.115083.
111. Robertson, K., R.E. Milliken, C.M. Pieters, L. Cheek, and P. Isaacson (2022), Textural and compositional effects of ilmenite on the spectra of high-Ti lunar basalts, *Icarus*, 375, doi: 10.1016/j.icarus.2021.114836.

2021

110. Sheppard, R.Y., M. Thorpe, A. Fraeman, V.K. Fox, and R.E. Milliken (2021), Merging perspectives on secondary minerals on Mars: A review of ancient water-rock interactions in Gale crater inferred from orbital and in-situ observations, *Minerals*, 11(9), 986, doi: 10.3390/min11090986.
109. Hiroi, T., H. Kaiden, N. Imae, K. Misawa, H. Kojima, S. Sasaki, M. Matsuoka, T. Nakamura, D.L. Bish, K. Ohtsuka, K.T. Howard, K.R. Robertson, and R.E. Milliken (2021), UV-visible-infrared spectral survey of Antarctic carbonaceous chondrite chips, *Polar Science*, 100723.
108. Bristow, T.F. , J. P. Grotzinger, E. B. Rampe, J. Cuadros, S. J. Chipera, G. W. Downs, C. M. Fedo, J. Frydenvang, A. C. McAdam, R. V. Morris, C. N. Achilles, D. F. Blake, N. Castle, P. Craig, D. J. Des Marais, R. T. Downs, R. M. Hazen, D. W. Ming, S. M. Morrison, M. T. Thorpe, A. H. Treiman, V. Tu, D. T. Vaniman, A. S. Yen, R. Gellert, P. R. Mahaffy, R. C. Wiens, A. B. Bryk, K. A. Bennett, V. K. Fox, R. E. Milliken, A. A. Fraeman, and A. R. Vasavada (2021), Brine-driven destruction of clay minerals in Gale Crater, Mars, *Science*, 373 (6551), 198-204, doi: 10.1126/science.abg5449.
107. Johnson, B.C., R.E. Milliken, K.W. Lewis, and G.S. Collins (2021), Impact-generated porosity in Gale crater and implications for the density of sedimentary rocks in lower Aeolis Mons, *Icarus*, 366, 114539.
106. *Sheppard, R.Y., R.E. Milliken, J.M. Russell, E.C. Sklute, M.D. Dyar, H. Vogel, M. Melles, S. Bijaksana, A.K.M. Hasberg, and M.A. Morlock (2021), Iron mineralogy and sediment color in a 100 m drill core from Lake Towuti, Indonesia, *Geochemistry, Geophysics, Geosystems*, 22, e2020GC009582, doi: 10.1029/2020GC009582.
105. *Florez, D., C. Huber, R.E. Milliken, and J. Berkson (2021), Modeling lunar pyroclasts to probe the volatile content of the lunar interior, *JGR Planets*, 126, doi: 10.1029/2020JE006645.

104. *Bramble, M., R.E. Milliken, and W. Patterson III (2021), Thermal emission measurements of ordinary chondrite mineral analogs in a simulated asteroid environment: 2. Representative mineral mixtures, *Icarus*, 369, doi: 10.1016/j.icarus.2020.114251.
103. *Bramble, M., R.E. Milliken, and W. Patterson III (2021), Thermal emission measurements of ordinary chondrite mineral analogs in a simulated asteroid environment: 1. Constituent mineral phases, *Icarus*, 369, doi: 10.1016/j.icarus.2021.114561.
102. Kitazato, K., R.E. Milliken, T. Iwata and 61 others (2021), Thermally altered subsurface material of asteroid 162173 Ryugu, *Nature Astronomy*, 5, 246-250, doi: 10.1038/s41550-020-01271-2.
101. Riu, L., C. Pilorget, R.E. Milliken, K. Kitazato, T. Nakamura, Y. Cho, M. Matsuoka, S. Sugita, M. Abe, S. Matsuura, M. Ohtake, S. Kameda, N. Sakatani, E. Tatsumi, Y. Yokota, and T. Iwata (2021), Spectral characterization of the craters of Ryugu as observed by the NIRS3 instrument onboard Hayabusa2, *Icarus*, 357, 114253, doi: 10.1016/j.icarus.2020.114253.
100. *Sheppard, R., R.E. Milliken, M. Parente, and Y. Itoh (2021), Updated perspectives and hypotheses on the mineralogy of lower Mt. Sharp, Mars, as seen from orbit, *JGR Planets*, 126, doi: 10.1029/2020JE006372.

2020

99. *Anzures, B.A., S.W. Parman, R.E. Milliken, A. Lanzirotti, and M. Newville (2020), XANES spectroscopy of sulfides stable under reducing conditions, *American Mineralogist*, 105(3), 375-381, doi: 10.2138/am-2020-7146.
98. *Anzures, B., S. Parman, R.E. Milliken, O. Namur, C. Cartier, S. Wang (2020), Effect of sulfur speciation on chemical and physical properties of very reduced mercurian melts, *Geochimica et Cosmochimica Acta*, 286, 1-18, doi: 10.1016/j.gca.2020.07.024.
97. *Sun, V. Z. and R.E. Milliken (2020), Characterizing the mineral assemblages of hot spring environments and applications to Mars orbital data, *Astrobiology*, 20 (4), doi: 10.1089/ast.2018.2003.

2019

96. *Bramble, M.S., *Y. Yang, R.E. Milliken, W.R. Patterson II, J.F. Mustard and K. Donaldson Hanna (2019), Radiometric calibration of thermal emission data from the Asteroid Lunar Environment Chamber (ALEC), *Reviews of Scientific Instruments*, 90, 093101, doi: 10.1063/1.5096363.
95. Kitazato, K., R.E. Milliken, T. Iwata and 61 others (2019), The surface composition of asteroid 162173 Ryugu from Hayabusa2 near-infrared spectroscopy, *Science*, 364, 272-275, doi: 10.1126/science.aav7432.

94. *Sheppard, R., R.E. Milliken, J.M. Russell, M.D. Dyar, E.C. Sklute, H. Vogel, M. Melles, S. Bijaksana, M. Morlock, A. Hasberg, and the TDP Science Team (2019), Characterization of iron in Lake Towuti sediment, *Chemical Geology*, 512, 11-30, doi:10.1016/j.chemgeo.2019.02.029.
93. *Kaplan, H.H., R.E. Milliken, C. M. O'D. Alexander, and C.D.K. Herd (2019), Reflectance spectroscopy of insoluble organic matter (IOM) and carbonaceous meteorites, *Meteoritics and Planetary Science*, 1-18, doi: 10.1111/maps.13264
92. *Yang, Y., S. Li, R.E. Milliken, H. Zhang, K. Robertson and T. Hiroi (2019), Phase functions of typical lunar surface minerals derived for the Hapke model and implications for visible to near-infrared spectral unmixing, *Journal of Geophysical Research*, 124, doi:10.1029/2018JE005713
91. *Bramble, M., T. Goudge, R.E. Milliken, and J.F. Mustard (2019), Testing the deltaic origin of fan deposits at Bradbury Crater, Mars, *Icarus*, 319, 363-366, doi:10.1016/j.icarus.2018.09.024.

2018

90. *Sun, V. and R.E. Milliken (2018), Distinct geologic settings of opal-A and more crystalline hydrated silica on Mars, *Geophysical Research Letters*, 45, doi:10.1029/2018GL078494.
89. †Li, S., P. Lucey, R.E. Milliken, P. Hayne, E. Fisher, J.P. Williams, and R. Elphic (2018), Detection of water ice at the lunar poles using Moon Mineralogy Mapper Data, *Proceedings of the National Academy of Sciences*, 115(36), 8907-8912, doi:10.1073/pnas.1802345115.
88. *Kaplan, H.H. and R.E. Milliken (2018), Reflectance spectroscopy of organic matter in sedimentary rocks at mid-infrared wavelengths, *Clays and Clay Minerals*, 66(2), 173-189, doi:10.1346/CCMN.2018.064092.
87. *Kaplan, H.H., R.E. Milliken, and C. M. O'D. Alexander (2018), New constraints on the abundance and composition of organic matter on Ceres, *Geophysical Research Letters*, 45, 5274-5282, doi: 10.1029/2018GL077913
86. McMahon, S., T. Bosak, J.P. Grotzinger, R.E. Milliken, R.E. Summons, M. Daye, S.A. Newman, A. Fraeman, K.H. Williford, and D.E.G. Briggs (2018), A field guide to finding fossils on Mars, *Journal of Geophysical Research*, 123, 1012-1040.

2017

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10. Milliken, R. E., J. F. Mustard, F. Poulet, D. Jouglet, J.-P. Bibring, B. Gondet, Y. Langevin, and the OMEGA team (2007), Hydration state of the Martian surface as seen by Mars Express OMEGA II: H₂O content of the surface, *J. Geophysical Research*, 112(E8), doi: 10.1029/2006JE002853.
9. Jouglet, D., F. Poulet, R. E. Milliken, J. F. Mustard, J.-P. Bibring, Y. Langevin, B. Gondet, and the OMEGA team (2007), Hydration state of the Martian surface as seen by Mars Express OMEGA I: Analysis of the 3 μ m hydration feature, *J. Geophysical Research*, 112(E8), doi: 10.1029/2006JE002846.
8. Milliken, R. E. and J. F. Mustard (2007), Estimating the water content of hydrated minerals using reflectance spectroscopy I: Effects of darkening agents and low-albedo materials, *Icarus*, 189, 550-573.
7. Milliken, R. E. and J. F. Mustard (2007), Estimating the water content of hydrated minerals using reflectance spectroscopy II: Effects of particle size, *Icarus*, 189, 574-588.
6. Pelkey, S. M., J. F. Mustard, S. Murchie, R. T. Clancy, M. Wolff, M. Smith, R. E. Milliken, J.-P. Bibring, A. Gendrin, F. Poulet, Y. Langevin, B. Gondet (2007), CRISM multispectral summary products: Parameterizing mineral diversity on Mars from reflectance spectra, *J. Geophysical Research*, 112(E8), doi: 10.1029/2006JE002831.

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5. Milliken, R. E., and J. F. Mustard (2005), Quantifying absolute water content of minerals using near-infrared reflectance spectroscopy, *J. Geophysical Research*, 110(E12), doi: 10.1029/2005JE002534.

2003

4. Head, J. W., J. F. Mustard, M. A. Kreslavsky, R. E. Milliken, and D. R. Marchant (2003), Recent ice ages on Mars, *Nature*, 426, 797-802.
3. Milliken, R. E., J. F. Mustard, and D. L. Goldsby (2003), Viscous flow features on the surface of Mars: Observations from high-resolution Mars Orbiter Camera (MOC) images, *J. Geophysical Research*, 108(E6), doi: 10.1029/2002JE002005.

c. Non-refereed Journal Articles (* indicates student advisee; † indicates postdoctoral advisee)

2. Milliken, R.E. and D. L. Bish (2011), Clays beyond Earth, *Clays and Clay Minerals*, 59(4), 337-338.
1. Grotzinger, J., D. Beaty, G. Dromart, S. Gupta, M. Harris, J. Hurowitz, G. Kocurek, S. McLennan, R.E. Milliken, G. Ori, and D. Sumner (2011), The sedimentary record of Mars, *The Sedimentary Record*, 9(2). 4-8.

6. SELECTED INVITED TALKS

2019 *Harvard University*

Detecting water and organics on primitive asteroids: Lessons learned from the lab and new results from the Hayabusa2 and OSIRIS-REx asteroid sample return missions, Boston, MA (12/2019).

Harvard University

Water on the Moon, Boston, MA (5/2019).

2015 *46th Lunar and Planetary Science Conference*

The nature of hydrated minerals Mars: Linking orbital and rover observations to constrain the climatic evolution of Mars, Abstract #2736 (3/2015).

Indiana University

Water in the Solar System: A story in three acts, Bloomington, IN (3/2015).

2014 *Stony Brook University*

Water beyond Earth, Stony Brook, NY (11/2014).

Geological Society of America Annual Meeting

Diagenesis on Mars and indications of prolonged water-rock interaction, Vancouver, BC (10/2014).

AAPG Annual Meeting

Mineral mapping of Gale Crater using orbital data: results from visible-near infrared reflectance spectroscopy, Houston, TX (4/2014).

2013 *Geological Society of America Annual Meeting*

- Water on the Moon: Quantitative spatial and temporal variations as seen by the Moon Mineralogy Mapper, Denver, CO (10/2013).
- 2012 *Geological Society of America Annual Meeting*
Gale Crater as a key reference section in understanding the global stratigraphy of Mars, Charlotte, NC (11/2012).
Harvard University
Water beyond Earth, Boston, MA (3/2012).
- 2011 *Fall Meeting of the American Geophysical Union*
Mixed-layered clays as evidence for widespread diagenesis on Mars, San Francisco, CA (12/2011).
Fall Meeting of the American Geophysical Union
The mineralogical stratigraphy of Gale Crater: A record of changing environmental conditions on ancient Mars, San Francisco, CA (12/2011).
Brown University
Water beyond Earth: A story of hydration in three acts, Providence, RI (11/2011).
Purdue University
Water beyond Earth, West Lafayette, IN (2/2011).
- 2010 *Geological Society of America Annual Meeting*
Water beyond Earth: A remote-sensing perspective on the role of aqueous processes in the Solar System, Denver, CO (11/2010).
- 2009 *Univ. Montana, Missoula, Winston-Thompson Symposium*
Types, origins, and long-term stability of clays on Mars, Missoula, MT (9/2009).
University of Notre Dame
Alteration minerals as indicators of environmental change in the rock record, South Bend, IN (4/2009).
Mineralogical Society of Southern California
Opal and other mysterious minerals on Mars, Pasadena, CA (1/2009).
- 2008 *Geological Society of America Annual Meeting*
Understanding sedimentary sources and sinks on Mars from orbit, Houston, TX (10/2008).
University of Tennessee
Clay minerals and opal on Mars: Formation mechanisms and depositional environments, Knoxville, TN (2/2008).
Ground Truth from Mars: Science Payoff from a Sample Return Mission Workshop
Interpreting and constraining the composition and depositional environments of phyllosilicates on Mars, #4036, Albuquerque, NM (4/2008).

7. SELECTED ABSTRACTS (*student advisee; † postdoc advisee)

2023

- Brunetto, R., Lantz, C., Fukuda, Y., Aléon-Toppani, A., Nakamura, T., Dionnet, Z. et al. (2023). Ryugu's Anhydrous Ingredients Share Spectral Similarities with Primitive Dust from the Outer Solar System. *Asteroids, Comets, Meteors Conference*, Abstract #2108.
- Das, E., Glotch, T. D., Edwards, C. S., Ye, C., Milliken, R. E., & Mitra, K. (2023). Investigating the Age, Abundance and Origin of Chloride Salt-Bearing Deposits on Mars. *54th Lunar and Planetary Science Conference*, Abstract #1680.
- Hiroi, T., Milliken, R. E., Robertson, K. M., Schultz, C. D., Amano, K., Nakamura, T. et al. (2023). Evidence of Space Weathering on the CII-Chondrite Asteroid 162173 Ryugu. *54th Lunar and Planetary Science Conference*, Abstract #1040.
- Meyer, M. J., Milliken, R. E., Robertson, K. M., & Ozdowski, N. M. (2023). Petrographic and Mineralogic Ground-Truth for Airborne-Based Hyperspectral Maps of Sedimentary Rocks: A Case Study in the Guadalupe Mountains, New Mexico and Implications for Mars. *54th Lunar and Planetary Science Conference*, Abstract #1383.
- Schultz, C. D., Milliken, R. E., Boesenberg, J. S., & Kerraouch, I. (2023). Hiding in Plain Sight: Towards a Framework for Spectral Interpretation in Brecciated Meteorites and Asteroids. *86th Annual Meeting of the Meteoritical Society*, Abstract #6001.
- Wilk, K. A., Mustard, J. F., Milliken, R. E., & Pieters, C. M. (2023). Effect of Surface Adsorbed H₂O/OH on Lunar Relevant Minerals at 3 and 6 Microns. *54th Lunar and Planetary Science Conference*, Abstract #2316.
- Wilson, M. M., & Milliken, R. E. (2023). Constraining Sources and Sinks of Hydrated Minerals in the Uzboi-Landon-Morava Outflow System, Mars. *54th Lunar and Planetary Science Conference*, Abstract #2331.

2022

- Amano, K., Matsuoka, M., Nakamura, T., Kagawa, E., Fujioka, Y., Potin, S. M. et al. (2022). Visible-IR Spectroscopic Diversity of Ryugu Coarse Grains and Comparison to Spectral Properties of Carbonaceous Chondrites. *85th Annual Meeting of The Meteoritical Society*, Abstract #6166.
- Amano, K., Matsuoka, M., Nakamura, T., Kagawa, E., Hiroi, T., Tatsumi, E. et al. (2022). Reflectance Spectral Comparison Between a Large Ryugu Returned Sample and Carbonaceous Chondrites. *53rd Lunar and Planetary Science Conference*, Houston, TX, Abstract #1789.
- Das, E., Glotch, T. D., Edwards, C. S., Ye, C., & Milliken, R. E. (2022). Hapke-Based Laboratory and Remote Determination of Martian Chloride Salt Abundances. *53rd LPSC*, Houston, TX, Abstract #1480.
- Hiroi, T., Ohtsuka, K., Zolensky, M. E., Rutherford, M. J., & Milliken, R. E. (2022). Tagish Lake is Still the Only Possible Meteorite Sample from D-Type Asteroids. *53rd LPSC*, Houston, TX, Abstract #1149.

- Lantz, C., Brunetto, R., Dionnet, Z., Nakamura, T., Aléon-Toppani, A., Baklouti, D. et al. (2022). Visible and IR Hyperspectral Imaging of Ryugu Samples Compared to Meteorites and to Remote Sensing of Bennu and Other Primitive Asteroids. *53rd LPSC*, Houston, TX, Abstract #1866.
- *Meyer, M. J., Milliken, R. E., & Robertson, K. M. (2022). Testing Airborne-Based Mineralogical and Geologic Mapping of Sedimentary Rocks: A Case Study in the Guadalupe Mountains, New Mexico and Implications for Mars. *53rd LPSC*, Houston, TX, Abstract #1941.
- *Meyer, M. J., Milliken, R. E., & Stack, K. M. (2022). Ground Truthing Orbital Layer Boundaries In Situ Along Curiosity's Traverse: Markers of Change in Sedimentary Textures, Diagenesis, Both, or Neither. *53rd LPSC*, Houston, TX, Abstract #1934.
- Milliken, R. E., Hiroi, T., *Schultz, C., Robertson, K., Brunetto, R., Lantz, C. et al. (2022). Spectroscopic Ground Truthing of a Carbonaceous Asteroid: Initial Reflectance Spectra of Ryugu Samples and Implications for Remote Observations. *53rd LPSC*, Houston, TX, Abstract #1556.
- Nakamura, T., Matsumoto, M., Amano, K., Enokido, Y., Zolensky, M., Mikouchi, T. et al. (2022). Analysis of "Stone" Samples from C-Type Asteroid Ryugu. *85th Annual Meeting of The Meteoritical Society*, Abstract #6190.
- Nakamura, T., Matsumoto, M., Amano, K., Enokido, Y., Zolensky, M. E., Mikouchi, T. et al. (2022). Early History of Ryugu's Parent Asteroid: Evidence from Return Sample. *53rd LPSC*, Houston, TX, Abstract #1753.
- *Schultz, C. D., Anzures, B. A., Milliken, R. E., & Hiroi, T. (2022). How Variable are Hydration Signatures of CM2 Chondrites? — Comparing Spectra of Meteorite Powders and Chips Across Multiple Spatial Scales. *53rd LPSC*, Houston, TX, Abstract #1572.
- *Wilk, K. A., Mustard, J. F., Kremer, C. H., & Milliken, R. E. (2022). Exploring the Utility of the Water Absorption Feature at 6.1 Microns. *53rd LPSC*, Houston, TX, Abstract #2704.
- *Wilson, M. M., Milliken, R. E., & Gough, R. V. (2022). Water Cycling of Hydrated Minerals Under Mars-Relevant Conditions and Implications for Interpreting Near-IR Spectra of Mars. *53rd LPSC*, Houston, TX, Abstract #2364.

8. FUNDING

Total dollar amount of awards as PI/Co-I over career: >\$38M (>\$16M to Milliken)
does not include awards w/Milliken as PI solely for administrative purposes (i.e. NASA EPSCoR awards)

a. Active

Total: \$6.7M as PI/Co-I (not including \$7.5M NASA SSERVI)

Title: NASA Rhode Island Space Grant Program & AI Workforce Dev. Augmentation
PI: Ralph Milliken (Brown University)
Role: PI
Source: NASA OSTEM (National Space Grant College & Fellowship Program)

Amount:	\$3.56M	Duration: 2025-2029
Title:	AI Workforce Development Augmentation for NASA Rhode Island Space Grant	
PI:	Ralph Milliken (Brown University)	
Role:	PI	
Source:	NASA OSTEM (National Space Grant College & Fellowship Program)	
Amount:	\$600k	Duration: 2026-2029
Title:	Established Program to Stimulate Competitive Research (EPSCoR) – Research Infrastructure Development (RID)	
PI:	Ralph Milliken (Brown University)	
Role:	PI	
Source:	NASA OSTEM (EPSCoR)	
Amount:	\$1.33M	Duration: 2022-2027
Title:	<u>Lunar Structure, Composition, and Processes for Exploration</u> (LunaSCOPE)	
PI:	Alex Evans (Brown University)	
Role:	Co-I	
Source:	NASA SSERVI	
Amount:	\$7.5M	Duration: 2023-2028
Title:	Towards distinguishing detrital and authigenic components in martian sedimentary rocks using rover-based payloads	
PI:	Ralph Milliken (Brown University)	
Role:	PI; Future Investigator (FI): Katya Yanez	
Source:	Future Investigators in NASA Earth & Space Science & Technology (FINESST)	
Amount:	\$150k (entirety to Milliken for student K. Yanez)	Duration: 2024-2027
Title:	The Reflectance Experiment LABORatory (RELAB) facility	
PI:	Ralph Milliken (Brown Univ.)	
Role:	PI	
Source:	NASA Planetary Science Enabling Facilities	
Amount:	\$1.1M	Duration: 2023–2026

b. Active: Administrative Only (as Director of NASA Rhode Island EPSCoR)

Total: \$0

None currently.

c. Completed

Total: \$23.9M

Title:	NASA Rhode Island Space Grant Program	
PI:	Ralph Milliken (Brown University)	
Role:	PI	
Source:	NASA OSTEM (National Space Grant College & Fellowship Program)	
Amount:	\$4.24M	Duration: 2020-2026
Title:	OSIRIS-REx Mission – Bennu sample analysis support	

PI: Dante Lauretta (University of Arizona)
 Role: Co-I
 Source: NASA OSIRIS-REx Mission
 Amount: \$944k (amount to Milliken) Duration: 2020-2025

Title: An experimental approach to assessing the role of hydrous minerals in the martian hydrological cycle
 PI: Ralph Milliken (Brown University)
 Role: PI
 Source: NASA Solar System Workings Program
 Amount: \$437k Duration: 2020-2025

Title: Remote geologic interpretation at rover, airborne, and orbital scales: Improving our ability to recognize potential biosignatures on Mars
 PI: Ralph Milliken (Brown University)
 Role: PI; Future Investigator (FI): Melissa Meyer
 Source: Future Investigators in NASA Earth & Space Science & Technology (FINESST)
 Amount: \$135k (entirety to Milliken & student M. Meyer) Duration: 2020-2024

Title: Enhancing the RELAB spectral database for the modern era of planetary science
 PI: Dr. Ralph Milliken (Brown Univ.)
 Role: PI
 Source: NASA SMD Standalone Submission 2022
 Amount: \$50k Duration: 2022–2023

Title: Enhancing the RELAB spectral database for the modern era of planetary science
 PI: Ralph Milliken (Brown University)
 Role: PI
 Source: NASA Planetary Data Archiving, Restoration, and Tools (PDART)
 Amount: \$990k Duration: 2016-2022

Title: Global modal mineralogy of Vesta and links to HEDs using Dawn VIR data
 PI: Ralph Milliken (Brown University)
 Role: PI
 Source: NASA Discovery Data Analysis Program (DDAP)
 Amount: \$358k Duration: 2017-2022

Title: The Chemical and Mineralogical Stratigraphy of Mt. Sharp
 PI: Ralph Milliken (Brown University)
 Role: PI
 Source: NASA MSL Rover Participating Scientist Program (MSL-PS2)
 Amount: \$421k Duration: 2016-2022

Title: SSERVI: Evolution and Environment of Exploration Destinations
 PI: Carle Pieters (Brown University)
 Role: Co-I
 Source: NASA Solar System Exploration Research Virtual Institute (SSERVI)
 Amount: \$6M (\$353k augmentation to Milliken for RELAB) Duration: 2014-2019

Title: Compact Reconnaissance Imaging Spectrometer for Mars
 PI: John Mustard (Brown University)
 Role: Co-I

Source: NASA Mars Reconnaissance Orbiter, Extended Mission 4
Amount: \$228k (\$50k to Milliken) Duration: 2016-2019

Title: Foundations of complex life: Evolution, preservation and detection
PI: Roger Summons (MIT)
Role: Co-I / Brown Univ. PI
Source: NASA Astrobiology Institute (NAI)
Amount: \$7.95M (\$372k to Milliken) Duration: 2013-2017

Title: Quantifying the hydration state of the lunar surface
PI: Ralph Milliken (Brown University)
Role: PI
Source: NASA Lunar Advanced Science & Exploration Research (LASER)
Amount: \$211k Duration: 2011-2016

Title: Quantifying hydration properties on Mars: Linking rover, orbital, & lab data
PI: Ralph Milliken (Brown University)
Role: PI
Source: NASA MSL Rover Participating Scientist Program (MSL-PS1)
Amount: \$680k Duration: 2011-2016

Title: Martian clays: Types, origins, and geothermometers
PI: Ralph Milliken (Brown University)
Role: PI
Source: NASA Mars Data Analysis Program (MDAP)
Amount: \$302k Duration: 2012-2015

Title: Obliquity-controlled water vapor/trace gas feedback on Mars
PI: Michael Mischna (Jet Propulsion Lab)
Role: Co-I
Source: NASA Mars Fundamental Research (MFRP)
Amount: \$360k (\$37k to Milliken) Duration: 2011-2014

Title: Laboratory and field studies of silica deposits with relevance to Mars
PI: Steve Ruff (Arizona State University)
Role: Co-I
Source: NASA Mars Fundamental Research Program (MFRP)
Amount: \$606k (\$106k to Milliken) Duration: 2011-2015

d. Completed: Administrative Only (as Director of NASA Rhode Island EPSCoR)
Total: \$2.0M

Title: Planetary methane in ultramafic contexts: searching for cyclicity in methane emissions at a planetary analog site in northern California
PI: Ralph Milliken (Brown University), *administrative/management only*
Role: PI (Science PI: Prof. Dawn Cardace, Univ. of Rhode Island)
Source: NASA OSTEM (EPSCoR)
Amount: \$750k Duration: 9/2022 - 9/2026

Title: Efficient and high-quality space robotic teleoperation through neural scene and object reconstruction
PI: Ralph Milliken (Brown University), *administrative/management only*
Role: PI (Science PI: Prof. James Tompkin, Brown University, Computer Science)
Source: NASA OSTEM (EPSCoR)
Amount: \$750k Duration: 8/2023 - 8/2026

Title: Precipitation extremes and land-sea biogeochemical connections in the California Current System
 PI: Ralph Milliken (Brown University), *administrative/management only*
 Role: PI (Science PI: Prof. Mara Freilich, Brown University, Earth, Env. Planetary Sci.)
 Source: NASA OSTEM (EPSCoR) Rapid Response to Research
 Amount: \$100k Duration: 9/2024 - 9/2026

Title: Computational design of 3D-printed battery architecture for flexible solid-state sodium batteries
 PI: Ralph Milliken (Brown University), *administrative/management only*
 Role: PI (Science PI: Prof. Yue Qi, Brown University, Engineering)
 Source: NASA OSTEM (EPSCoR) Rapid Response to Research
 Amount: \$100k Duration: 9/2024 - 9/2026

Title: Improving space solar specific power through tailored photon-concentration devices
 PI: Ralph Milliken (Brown University), *administrative/management only*
 Role: PI (Science PI: Prof. Ou Chen, Brown University, Chemistry)
 Source: NASA OSTEM (EPSCoR) Rapid Response to Research
 Amount: \$100k Duration: 7/2023 - 6/2024

Title: Multiphoton entangled state and plasmonic mediation
 PI: Ralph Milliken (Brown University), *administrative/management only*
 Role: PI (Science PI: Prof. Jimmy Xu, Brown University, Engineering)
 Source: NASA OSTEM (EPSCoR) Rapid Response to Research
 Amount: \$100k Duration: 8/2023 - 8/2024

Title: Bubble emulsions in microgravity
 PI: Ralph Milliken (Brown University), *administrative/management only*
 Role: PI (Science PI: Prof. Roberto Zenit, Brown University, Engineering)
 Source: NASA OSTEM (EPSCoR) Rapid Response to Research
 Amount: \$100k Duration: 9/2024 - 9/2025

9. SERVICE

a. University & Department

- Ph.D. Thesis Committee Member (former; not including primary advisees)

Timothy Goudge (2015)	Rebecca Greenberger (2015)
Kevin Cannon (2017)	William Daniels (2017)
Terik Daly (2017)	Tess Caswell (2018)
Richard Vachula (2019)	Nora Richter (2020)
Jennifer Kowalczyk (2023)	
- Preliminary Examination Committee Member (not including primary advisees)

Timothy Goudge (2013)	Rebecca Greenberger (2013)
Brooks Proctor (2014)	Kevin Cannon (2014)
Terik Daly (2014)	Erica Jawin (2015)
Leif Tokle (2017)	Michael Bramble (2017)
Nora Richter (2018)	Ariel Deutsch (2018)
Alyssa Pascuzzo (2018)	Jesse Tarnas (2019)
Sierra Kaufman (2019)	Evan Bjornes (2019)

- Jennifer Kowalczyk (2020) Fiona Nichols-Fleming (2021)
- Sebastian Perez-Lopez (2024)
- Graduate Student Advising Committee Member (current; not including primary advisees)
 - Kierra Wilk Sebastian Perez-Lopez
 - Riley Havel
- DEEPS Curriculum Committee (2013-present; chair for 2015-2021, 2024- present)
- DEEPS Chair's Advisory Committee (2021-present)
- Chair of search committee for faculty hire in planetary science (AY 23/24)
- Chair of search committee for faculty hire in planetary science (AY 21/22)
- Lead for target of opportunity faculty hire in planetary science (2017)
- DEEPS Diversity & Inclusion Action Committee (2019 – 2021)
- Radiation Safety Committee (University, 2017-2022)
- College Curriculum Council (University, July 2016-July 2018)
- Outside Colloquium Speaker Scheduler (DEEPS, Spring 2014)
- Physical Facilities Committee (DEEPS, 2013-2015)
- Member of search committee for faculty hire in planetary science (AY 14/15)

b. Profession

- Director, NASA Reflectance Experiment LABoratory (RELAB) facility at Brown University (2013-present)
- Director, NASA Rhode Island Space Grant Consortium (2022 – present)
Statewide program consisting of 11 institutions focused on providing funding, research, and other STEM educational opportunities for students and educators at all levels
- Director, NASA Rhode Island EPSCoR (2022 – present)
Statewide Established Program to Stimulate Competitive Research focused on developing and strengthening collaborations between RI-based universities, colleges, industries, and other stakeholders, with an emphasis on long-term funding streams
- NASA EPSCoR Executive Committee, member (2023 – present)
- Extraterrestrial Materials Analysis Group (ExMAG), Working Group on Astromaterials Data Management and Archiving (2023 – 2025)
- Reviewer of scientific articles (~3-5/year) for peer-reviewed journals that have included:

Science	Nature	Nature Geoscience
Science Advances	Nature Communications	Nature Astronomy
Geology	J. Geophysical Research	Geophysical Research Letters
Icarus	Clays & Clay Minerals	Meteoritics & Planetary Science
Clay Minerals	Space Science Reviews	Proc. National Academy of Science
Planetary Science Journal		
- Reviewer of numerous proposals (~4/year) for various NASA and NSF funding programs as well as international funding agencies (e.g., NWO [Netherlands], SNSF [Switzerland], JAXA [Japan], NKFIH [Hungary], PRESTIGE Marie Curie fellowship [France]).
- Panel chair & member for various NASA Science Mission Directorate funding programs
- Reviewer of NASA Dawn mission (VIR instrument) data delivery to Planetary Data System public archive (2011 – 2019; 2024)
- Reviewer of NASA Lunar Trailblazer mission data delivery to Planetary Data System public archive (2023)

- Co-organizer of the *First International Conference on Mars Sedimentology and Stratigraphy*, Lunar and Planetary Institute, held in El Paso, TX of April 2010.
- Co-editor of a special issue on extraterrestrial clays for *Clays and Clay Minerals* (2011, vol. 59, no. 4).
- Co-organizer for a session on extraterrestrial clays for the *14th International Conference on Clays (ICC)* held in Italy, 2009 and for *16th ICC* held in Spain, 2017
- Co-organizer of sessions at GSA, AGU and Goldschmidt conferences.

c. Community Engagement

2024

Nayatt Elementary 1 st grade (~70 students)	The Sun & Moon	Barrington, RI
College Day @ Brown (local HS students)	Origins of Life & Sample Return	Providence, RI
Solar Eclipse 2024 @ Brown (public event)	NASA RI Space Grant	Providence, RI
Pleasant View Elementary 3 rd grade (~45 students)	Lunar Exploration	Providence, RI
RI Space Grant Annual Research Symposium (~80 attendees)	hosted @ Brown University	

2023

NASA ISS Downlink w/ K-12 students, in partnership w/ RI Science Teachers Assoc. all of RI (statewide event viewed live by >3,000 students and educators, organized class visits)

Del Sesto Middle School STEM night	Meteorites & the Moon	Providence, RI
Hampden Meadows Elementary 5 th grade (~20 students)	Lunch & Learn	Barrington, RI
Nayatt Elementary 3 rd grade (~25 students)	Lunch & Learn	Barrington, RI
RI Space Grant Annual Research Symposium (~70 attendees)	hosted @ Salve Regina University	

2022

Mount Hope High School @ Museum of Natural History (Providence)	Providence, RI
(Helped organize and oversee field trip for ~140 7 th graders to MNH & Planetarium show)	
RI Space Grant Annual Research Symposium (~50 attendees)	hosted @ Brown University

2019

Skyscrapers Inc. (~50 attendees)	Water on the Moon	N. Scituate, RI
Apollo 50 th Celebration @ WaterFire Arts Center (~50 attendees)	Water on the Moon	Providence, RI
Nayatt Elementary School 1 st grade (~15 students)	Asteroids!	Barrington, RI
Nayatt Elementary School 3 rd grade (~25 students)	Asteroids!	Barrington, RI

2016

Summer@Brown class (1 lecture; 24 attendees)	Habitability on Mars	Providence, RI
STEM I Conference @ Brown (middle schools; ~36 students)	Curiosity Rover	Providence, RI
SPARK class guest lecture (6 th -7 th graders; ~12 students)	Roving on Mars	Providence, RI

2015

Summer@Brown class (1 lecture; 15 attendees)	Habitability on Mars	Providence, RI
Vartan Gregorian Elementary (~60 students)	Searching for Life Beyond Earth	Providence, RI
STEM Day @ Brown University (~50 students)	The Curiosity Rover	Providence, RI

2014

Palmer River Elementary School (3 rd /4 th grade; ~280 students)	Roving Mars	Rehoboth, MA
Summer@Brown class (1 lecture; 14 attendees)	Habitability on Mars	Providence, RI
Brown Univ. Staff Advisory Committee (~25 attendees)	The Curiosity Rover	Providence, RI
STEM Day @ Brown University (~50 attendees)	The Curiosity Rover	Providence, RI
250 th Anniversary @ Brown (RI middle schools) (~40 students)	Roving Mars	Providence, RI

2013

Spectroscopy Society of Pittsburgh (~80 attendees)	A Year of Roving Mars	Pittsburgh, PA
Science Café (Brown University) (~30 attendees)	A Year of Roving Mars	Providence, RI
Maria Mitchell Association (~35 attendees)	A Year on Mars	Nantucket, MA
Summer@Brown class (1 lecture; 14 attendees)	Habitability on Mars	Providence, RI
Brown Univ. Staff Development Day (~50 attendees)	The Curiosity Rover	Providence, RI
Brown Univ. Staff Advisory Committee (~24 attendees)	The Curiosity Rover	Providence, RI
RI Space Grant Spring Symposium (~50 attendees)	The Curiosity Rover	Providence, RI
STEM Day @ Brown University (~40 attendees)	The Curiosity Rover	Providence, RI
South Shore Natural Science Center (~50 attendees)	Water on Mars	Norwell, MA
Skyscrapers Inc. (~50 attendees)	The Curiosity Rover	N. Scituate, RI
Vartan Gregorian Elementary School (~200 students)	Roving on Mars	Providence, RI
Gordon School 7 th Grade (~45 students)	Roving on Mars	E. Providence, RI
Gordon School 6 th Grade (~45 students)	Roving on Mars	E. Providence, RI

2012

Marquette Elementary School 5 th grade (~60 students)	The Geology of Mars	South Bend, IN
Marquette Elementary School 6 th grade (~50 students)	The Geology of Mars	South Bend, IN
Warren Elementary School 4 th grade (~60 students)	The Geology of Mars	South Bend, IN
Warren Elementary School 5 th grade (~60 students)	The Geology of Mars	South Bend, IN

Other

2009	Summer Undergraduate Research Fellowship Mentor	Caltech
2008	Summer Undergraduate Research Fellowship Mentor	JPL/Caltech
2006	Supplemental Science Instructor, 4 th grade	Providence Public Schools
2005	Supplemental Science Instructor, 4 th grade	Providence Public Schools

10. PROFESSIONAL MEMBERSHIPS, AWARDS, HONORS, & RECOGNITION

Professional Memberships & Societies

American Geophysical Union (AGU)
 Clay Minerals Society (CMS)
 Geological Society of America (GSA)
 Meteoritical Society (MetSoc)
 Mineralogical Society of America (MSA)
 Sigma Xi

Awards, Honors & Recognition

2014 Honored with naming of asteroid 9003 *Ralphmilliken* by the IAU
 2012 #1 most-highly-cited paper published in the journal *Geology* for year 2008: Milliken et al. (2008), Opaline silica in young deposits on Mars, *Geology*, v.36, 847-850. (source: GSA, December 2012) <http://geology.gsapubs.org/content/40/12/1147/T1.expansion.html>

2012	Portrait on stamp from Guinea commemorating the landing of the NASA Mars Curiosity rover in Gale Crater	
2009	Mariner/Ranger Award for Outstanding Publication	JPL
2006	Juokowsky Foundation Outstanding Dissertation Award nominee	Brown Univ.

11. TEACHING

a. Regular Courses & Field Trips

Brown

AY 2025/2026

Sabbatical, no courses taught

AY 2024/2025

(Spring)	EEPS 0810: <i>Planetary Geology</i>	154 enrolled
(Spring)	EEPS 2920C: <i>The Sedimentary Rock Cycle of Earth & Mars</i>	7 enrolled
(Fall)	EEPS 1710: <i>Remote Sensing of Earth and Planetary Surfaces</i>	9 enrolled

AY 2023/2024

(Spring)	EEPS 0810: <i>Planetary Geology</i>	117 enrolled
(Fall)	EEPS 1950Z: <i>To the Moon & Back: Lunar Exploration from Antiquity to Apollo to Artemis</i>	9 enrolled

AY 2022/2023

(Spring)	EEPS 0810: <i>Planetary Geology</i>	96 enrolled
(Fall)	EEPS 1710: <i>Remote Sensing of Earth and Planetary Surfaces</i>	5 enrolled
(Fall)	STS 1970: Independent Study in Science, Technology & Society	1 enrolled

AY 2021/2022

(Spring)	EEPS 0810: <i>Planetary Geology</i>	72 enrolled
(Fall)	EEPS 2840: <i>Asteroids and Meteorites</i>	8 enrolled

AY 2020/2021

(Spring)	EEPS 0810: <i>Planetary Geology</i>	123 enrolled
(Fall)	EEPS 2330: <i>Advanced Remote Sensing</i>	11 enrolled

AY 2019/2020

(Spring)	GEOL 0810: <i>Planetary Geology</i>	48 enrolled
(Spring)	GEOL 2920C: <i>The Sedimentary Rock Cycle of Earth & Mars</i>	6 enrolled
(Fall)	GEOL 1710: <i>Remote Sensing of Earth and Planetary Surfaces</i>	12 enrolled

AY 2018/2019

Sabbatical, no courses taught

AY 2017/2018

(Spring)	GEOL 0810: <i>Planetary Geology</i>	47 enrolled
(Spring)	GEOL 2920C: <i>The Sedimentary Rock Cycle of Earth & Mars</i>	9 enrolled
(Fall)	GEOL 1970: <i>Independent Study</i>	1 enrolled
(Fall)	GEOL 1710: <i>Remote Sensing of Earth and Planetary Surfaces</i>	13 enrolled

AY 2016/2017

(Spring)	GEOL 0810: <i>Planetary Geology</i>	76 enrolled
(Spring)	GEOL 2840: <i>Asteroids and Meteorites</i>	8 enrolled
(Fall)	Junior Sabbatical, no courses taught this semester	

AY 2015/2016

(Spring)	GEOL 0810: <i>Planetary Geology</i>	66 enrolled
(Spring)	GEOL 2920C: <i>The Sedimentary Rock Cycle of Earth & Mars</i>	8 enrolled
(Spring)	GEOL 1970: <i>Independent Study</i>	1 enrolled
(Fall)	DEEPS Fall Field Trip	19 attendees
(Fall)	GEOL 1710: <i>Remote Sensing of Earth and Planetary Surfaces</i>	6 enrolled

AY 2014/2015

(Spring)	GEOL 0810: <i>Planetary Geology</i>	35 enrolled
(Spring)	GEOL 2840: <i>Asteroids and Meteorites</i>	8 enrolled
(Fall)	GEOL 1710: <i>Remote Sensing of Earth and Planetary Surfaces</i>	6 enrolled

AY 2013/2014

(Spring)	GEOL 2920C: <i>The Sedimentary Rock Cycle of Earth & Mars</i>	9 enrolled
(Fall)	GEOL 2840: <i>Asteroids and Meteorites</i>	7 enrolled

AY 2012/2013

(Spring)	GEOL 1710: <i>Remote Sensing of Earth and Planetary Surfaces</i>	9 enrolled
(Spring)	GEOL 2920K: <i>The Hydrological Cycle of Mars</i>	9 enrolled
(Fall)	Teaching Relief (required residency at JPL for Mars Curiosity rover operations)	

Previous – University of Notre Dame

AY 2011/2012

2012 (Spring)	ENVG 10900/20900: <i>Planetary Geology</i>	25 enrolled
2012 (Spring)	ENVG 45200: <i>Geology Field Trip</i>	13 enrolled
2011 (Fall)	ENVG 40610: <i>Remote Sensing of Our Environment</i>	11 enrolled

AY 2010/2011

2011 (Spring)	ENVG 10900/20900: <i>Planetary Geology</i>	38 enrolled
2011 (Spring)	ENVG 45200: <i>Geology Field Trip</i>	23 enrolled

12. ADVISING

Current Graduate Student & Postdoc Advisees

Grad Student - Katya Yanez (Advisor for Ph.D.; entered 9/2023)
 Grad Student – Tatum Merges (Advisor for Ph.D; entering 9/2026)
 Grad Student – Aniruddha Ghosh (Advisor for Ph.D; entering 9/2026)

Former Advisees (current employment)

Graduate Students

Cody Schultz (Postdoctoral Researcher, Univ. Central Florida)
 Melissa Meyer (Lincoln Labs, MIT)
 Meg Wilson (not known)
 Brendan Anzures (Research Scientist, Jacobs Tech. at NASA Johnson Space Center)
 Rachel Sheppard (Marie Curie Postdoctoral Fellow at IAS, Université Paris-Saclay)
 Michael Bramble (Postdoctoral Researcher at NASA's Jet Propulsion Lab)
 David Tersegno (not known)
 Elizabeth Fisher (Advisor for Sc.M.; currently Ph.D. student at Univ. Hawaii)
 Yazhou Yang (Co-Advisor; visiting student through Chinese Scholarship Council)
 Vivian Sun (Systems Engineer at Jet Propulsion Lab/Caltech)
 Hannah Kaplan (Research Space Scientist at NASA Goddard)
 Shuai Li (Assistant Professor at U. of Hawaii, Manoa)

Kathryn Stack (Co-Advisor; Ph.D. at Caltech w/ Dr. John Grotzinger; Research Scientist at JPL/Caltech; Deputy Project Scientist for NASA Perseverance Mars rover)

Postdocs

Dr. Thomas Bristow (Research Scientist at NASA Ames)

Dr. Shuai Li (Assistant Professor at U. of Hawaii, Manoa)

Dr. Kevin Robertson (Research Associate at Brown University)

Dr. Cody Schultz (Postdoctoral Researcher at Univ. Central Florida)

Honors, Master's and Ph.D. Theses Directed/Co-Advised

Ph.D.

Cody Schultz (Ph.D., Brown University, 2024; Sc.M. Brown University, 2021)

Melissa (Meyer) Coronado (Ph.D., Brown University, 2024)

Brendan Anzures (Ph.D., Brown University, 2021; Sc.M. Brown University, 2018)

Rachel Sheppard (Ph.D., Brown University, 2020; Sc.M. Brown University, 2017)

Michael Bramble (Ph.D., Brown University, 2020; Sc.M. Brown University, 2016)

Hannah Kaplan (Ph.D., Brown University, 2018; Sc.M. Brown University, 2015)

Vivian Sun (Ph.D., Brown University, 2017; Sc.M. Brown University, 2015)

Shuai Li (Ph.D., Brown University, 2016; Sc.M. Brown University, 2014)

Kathryn Stack Morgan (Ph.D. co-advisor, Caltech 2014)

Sc.M. (terminal)

Meg Wilson (Sc.M., Brown University, 2024)

David Tersegno (Sc.M., Brown University, 2021)

Elizabeth Fisher (Sc.M., Brown University, 2020)

B.S./Honors Theses

Christopher Yen (Sc.B. in Geology w/Honors, Brown University 2019)

Amanda Siemann (B.S. in Geology w/ Honors, Univ. of Notre Dame 2012)